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SCIENCE

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ZOOLOGICAL AIMS AND OPPORTUNITIES

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It is hardly necessary to remind you that the stress of recent months has not been very favorable for the production of an address worthy of this occasion. I shall present no apologies or excuses for the shortcomings of my effort but it may be fair to state that the subject selected has been determined in part by the conditions of world turmoil through which we have been passing and the thoughts almost inevitably prompted by the rapidly shifting viewpoints in almost every phase of human thought.

Since we are human beings as well as zoologists it is natural that we should be confronted with questions as to the status of our science in the world problems of the day; the effects that may follow the immensely critical movements in human adjustments and, perhaps above all as to the bearing of our zoological knowledge, philosophy and instruction upon the shaping of human activities and human progress.

To merely state these questions would involve more time and a more comprehensive grasp of human affairs than I can claim; to attempt answers to them would involve prophetic vision as well as broad knowledge, but nevertheless I shall venture to present a few, perhaps disjointed, suggestions, believing them to be of imperative importance and in the hope that they may stimulate further interest and discussion.

It will help to form a basis for these suggestions to consider for a moment the method by which the science of zoology has developed and reached its present status. As with other sciences and human knowledge in general it

¹ Address of the retiring vice-president and chairman, Section F, Zoology, of the American Association for the Advancement of Science, Baltimore, December 27, 1918.

has been a matter of very irregular growth, now one phase, now another forging ahead; the mistakes of one generation being corrected by a later one and the faulty interpretations of limited knowledge clarified with wider basis of fact. Often the progress of one branch has been definitely halted till the developments in other fields have given the data necessary for a clear comprehension and satisfactory solution of its problems.

The rapid advance of one phase may have resulted from individual taste or interest or again from some insistent demand from an associated or dependent field. Comparative anatomy has been pushed forward by the needs of human anatomy; in fact many phases of zoology particularly related to medicine have had their progress determined by the needs of this applied science. The medical importance of certain mosquitoes and flies has stimulated tremendously the interest in these groups and the amount of study devoted to them.

Extremely destructive insects, from a human standpoint, have been investigated with far greater assiduity than is true of most of the species devoid of economic interest. Attractive habits or a human interest perhaps accounts for the fact that birds have been much more studied and are far better known than the worms on which they feed, and that ants, bees and wasps with social habits have claimed attention to the neglect of less highly specialized forms.

Primitive observations of the character and habits of animals, stimulated no doubt by the needs for food and the domestication of available forms, has grown into definite knowledge concerning the habits and life histories and other general matter. The study of animal activities must have been closely coincident with that of the animal mechanism and these gradually differentiated into the now almost too widely separated branches of morphology and physiology, while passing further into the realm of the interactions with surrounding forces or interrelations with other organisms has developed into the ecology of modern times. Recognition of the succession of gen-

erations of like animals laid the foundations for a knowledge of the main facts of heredity and these with later knowledge of the mechanism of inheritance gives us our modern conceptions of genetics.

Attempts to designate the various animals must have developed by slow degrees into the primitive recognition of species and quite naturally into the further association of groups of similar kinds such as birds, fishes, reptiles, etc., which were undoubtedly the beginnings of our systems of classification; systems whose complexities now sometimes become the despair of the initiated as well as of the amateur.

Comparison of the animals of different geographical regions involving the recognition of distribution, of adaptations to climate, topography and other natural features and to restriction of modes of life must have early entered into the realm of zoology. Curiosity as to the meaning of fossils grew with our sister science of geology into modern paleontology with all its significant contributions to the interpretation of life and its historic development.

Speculation as to the origin of animal life certainly came at an early date and the long tangle of conceptions of the processes of evolution which have culminated in our doctrine of descent was started on its devious path.

But it is not my purpose to trace in detail the growth of the different branches of zoological science. What I would like to emphasize just now is that we have a large number of quite distinct phases of our study and that these have become so specialized that the workers in one branch may have very little conception of the nature of the problems, the technique or the difficulties attending the advancement of knowledge in another branch.

In some cases this seems to have resulted in lack of sympathy or in misunderstandings that have served as a handicap to the progress of the science as a whole and a mutual recognition of the interdependence of all branches should be helpful in determining future progress. The truth is that there is no branch of zoology overworked or exhausted and there is

every reason for cordial recognition of the work being done in other fields than one's own specialty. Moreover, so dependent is one branch for its fullest development on the progress of related or supporting branches that any other attitude is to be deplored.

In a general way and for the purpose of my discussion we may separate zoological activities into two broad classes (1st) investigation, research or the accumulation of new knowledge and (2d) instruction or the distribution of this knowledge to the public at large.

In many ways the aims and methods of the two may differ and yet there is imperative need of the closest and most sympathetic contact between the two and among the workers in the different spheres. In many cases—and I believe most fortunately—the two functions are combined, but often such separation exists as to result in loss of effort or even conflict of action.

ZOOLOGICAL RESEARCH

It should go without saying that research must precede instruction at least as applied to any particular object although it would seem that this order is at times reversed.

We may sometimes discover quite munificent provision for education in a too narrow sense with little apparent recognition that the subjects covered are still little known or crudely assembled. Extended and careful investigation should be the first effort in order that accurate and useful knowledge may be available for instruction. Here too will arise the question as to the kind of research that should be given first and most insistent attention.

The point of view may be determined largely by the concept or ideal as to the ultimate goal of zoological effort. Have we a definite object or are we still, as in the early stages of our science, simply following attractive leads or the easiest trails to see whither they may carry us? Is it our greatest ambition to produce a zoological structure complete and perfect in itself as a scientific ideal or to give earliest and most effective service possible to all the agencies operating

for human progress and human welfare? Shall our immediate efforts be given to questions of most remote concern to present problems of life or shall we concentrate effort on those phases which by their relation to medicine or to industry have vital bearing on immediate human needs? Such questions must have come to many of us when searching our innermost thoughts for evidence as to what we could do to help "win the war." Such questions may well concern us in the history-making period that must now follow in the establishment of order and a new alignment of human relationships and activities and which must necessarily be of world-wide scope.

Perhaps we may reflect that these questions will be largely settled by the tastes and choice of the many individuals concerned and that the outcome will be a fairly well-balanced combination. Nevertheless it is evident that the question will come as an urgent one to many individuals and will affect their attitude both in research and instruction so that some sort of decision as to the direction of greatest emphasis will need to be made.

Admitting, however, that the final goal is economic advantage, the development of applied science for the betterment of human society, we may still inquire as to the route to the main objective. I would certainly be one of the first to accord a high place to all phases of science that have made and are making for human advancement. Human society is not only our greatest achievement so far but it offers the only basis we know for evolution and progress in conditions of world affairs that should make this earth the fittest place possible for human life.

But we must guard against a too narrow view of the values in scientific knowledge. That which is of the most immediate concern may be but temporary in its application and some of the most vital and enduring things may be less apparent.

It is fortunate therefore that along with the many agencies that are attacking the immediate problems of applied science we have numerous agencies interested in the explora-

tion and investigation of fields whose immediate contribution to human welfare may be difficult to discern. It is a well-known fact that many of our most important advances in applied zoology have been possible only with the basis of knowledge acquired in some field that seemed quite unrelated to human affairs. Instances will occur to all but such stock examples as the ecological relations of trichina, liver fluke and other parasites may serve to emphasize the point.

It may be suggested then that one of the great objectives for the immediate future is carrying forward our researches on all fronts, that we may secure cooperation and correlation in the various lines and that we aim at a more complete and perfect combination of fundamental knowledge, which may be accessible from all sides for the furtherance of such applications as may be needful in human progress.

Whatever our objective, it is interesting to inquire as to our conditions for progress, the lines of work that we may see most clearly ahead of us, the agencies through which we may press for their attainment and the helps or handicaps that are to be reckoned with in our efforts.

I feel sure no one will question the need of continuous effort in the line of structure both general and histological or of function and activities in the widest sense for tissues, organs and individuals. These constitute such an imperative basis for all work in embryology, life-history, activities and relationships that only the most superficial view would permit of a lessening of effort in these lines.

As we go further in economic lines we appreciate more and more that the control of organic nature for the advantage of man must be based on the most complete knowledge of the structures, functions, habits, responses and relationships of the organisms with which we must deal. Can we say of any animal that we know all about it, that needs to be taken into account, when we attempt to fix its place in nature or with reference to the organisms with which it may be associated?

Have we by any means exhausted the prob-

lems of structure, the physical factors in animal symmetry or correlation of organs or of the activities of animals in many phases. What of the mechanics of flight or aerial locomotion as exhibited in various groups? How do certain insects hover or fly backward, as in many different families or even fly upside down as is claimed for certain tabanids. And once these questions are satisfactorily answered there will still arise the question as to how such complicated activities had their origin, what were the structural bases on which they were built and what the forces that have operated in their evolution. Even the ultimate problem as to the nature of life itself must be solved, if ever, on the basis of those organic forces which though possibly only combinations of simpler chemical or physical forces are so indissolubly linked with organic structure that this must be our base of attack.

To enter another field and one of recent important strides, consider the wealth of unsolved problems concerning the relations of animals to their environment and to each other. These present, especially for the biological factors, some wonderfully intricate associations and the determinations except for a given time and place, perhaps, an impossible task, since the various elements are in constant process of change. But many of the more constant factors may be determined with approximate accuracy and allowing for periodic variations may afford a basis for some valuable deductions, even possibly, for useful economic practises. To cite a particular instance let me mention the study of the short-tailed shrew by Shull. Here is a species seldom attracting attention but widely dispersed, occurring in great abundance and with a variety of food that includes a large number of species that we consider very injurious along with many that are innocuous or possibly even beneficial. Doubtless we would find a different bill of fare for the species for every month of the year and possibly for every field in which we might study it, but the total appears to be decidedly in the animals favor.

The relation of birds in agriculture has been a most debated and debatable question and largely because of the inconstancy in food habits of many of the most familiar species. Considered strictly from an economic point of view there is little doubt that the status of many species is still open to investigation. So too the place of spiders in the ecologic association is one of much complexity along with that of a host of predaceous and parasitic forms. A phase of their relationship that seems however to be often overlooked is that except for the abundance of the species on which they subsist their presence in any given association could be dispensed with. Since they are dependent on forms that again are dependent on vegetation it is obvious on second thought that all such forms are indirectly a drain upon the plant element and, speaking agriculturally, might best be wanting if the host forms were absent.

I need not weary you with further examples but submit that here is a field of work of intense interest biologically, offering an infinite number of fascinating problems, calling for the finest ability in field observation and laboratory analysis and promising results of decided importance for economic applications in agriculture, forestry, fisheries and many other fields.

These animal associations lead quite naturally to the conditions shown among social species and these social organizations among various groups of animals, as also the psychology of the lower animals, offer much that is suggestive for the sociologist and psychologist and certainly there should be some point of contact for students in these various fields. It is only upon such broad biological foundation that we can build a rational sociology or philosophy both for zoology and for human life.

Certainly one of the great aims in our science is to discover as rapidly as possible all the forms of life that inhabit the earth and, I may add, all those for which we can gain evidence of existence in the geological ages of the past. Only with this knowledge in hand can future students expect to reach the most conclusive knowledge as to the inter-relations and inter-

actions of the organic world or the derivation, affinities and possible relation to human interests.

Zoological exploration has been a favorite activity in all the periods of zoological study. I see no possibility that its interest can lag so long as there are unexplored fragments of the earth's surface or the waters or the air surrounding it or unknown forms of life to be uncovered. Indeed with the greater facilities possible in modern transportation and communication we may expect a great impulse for this kind of work. "Impenetrable jungle" and "inaccessible" mountain peak may be brought within easy access of the modern airship while continuous means of wireless communication will greatly favor such enterprises. No doubt our zoological explorers will take advantage of these means and add tremendously to their contributions to science, and, probably, to the world's sources of wealth, convenience or enjoyment.

And what of our taxonomy? Will future generations be content to endure some of the enormities perpetrated under our system of nomenclature? Names we must have and recognition of specific, generic and other natural groups of organisms, so also uniformity and stability for the world of science, but I certainly have deep sympathy for the morphologists, physiologists, cytologists and other workers who must perforce use some name to designate the material on which their work is based and who find a most chaotic assemblage of names from which to select. Of course systematists are not alone in such troubles, as the terminologies of morphology, cytology, etc., appear to have some uncertainties of their own.

It is to be hoped that the efforts of the international commission may be supported and their work now pushed forward with renewed zeal. With closer and more universal relationship between workers in all countries it becomes more and more essential that we have a recognized and established system for all languages and all groups of animals. Especially important is the fixing of such names as are most generally used in research

and education, as here is where the burden falls most heavily on the workers who are not systematists. No taxonomist should have the heart and if possible should not have the power or the opportunity by shifting a genus or rearranging species to foist upon a patient world the necessity of adopting a new combination in the name of the common species universally referred to in anatomy, medicine, agriculture or other lines of applied science.

I have elsewhere hinted at the discouraging nature of these nomenclatural acrobatics to the student entering on zoological work. I have good reason to believe that many promising and brilliant young workers have been disgusted and drawn to other fields of effort because of the complexities and apparently senseless chaos involved in the synonymy of many of our common animals. Think of thirty-six different specific combinations for the oyster-shell scale (that is 36 the last time I had occasion to note the number) or twenty-six for the screw worm fly.

Particularly aggravating are such cases as the mosquito, cattle-tick and other forms related to disease and necessarily used by medical students. Clearly one of the most helpful things in zoological education would be a condition of stability in nomenclature which would permit us to assure our prospective zoologists of the coming generation that they would not have to learn and unlearn a succession of scientific names for the things with which they deal.

Some cases would be amusing if they were not so tragically wasteful in valuable time. I recall a student of cytology who was greatly puzzled because the chromosomes of two supposedly distinct species under different generic names were exactly the same, and whose relief may be imagined when he learned that they were one species identified from different collections under names of different vintage. He might well have been disgusted as well as relieved.

It is rather dangerous to suggest remedies or reform in this line but I venture to offer one, which is that systematists curb their desire to form new genera and limit these so

far as possible to new species or use special care not to shift into a new genus any of the common species whose names have been for a long time in general use. The concept of genus is an indefinite one; more than the species it may be subject to wide individual interpretation, but to multiply generic names and so necessitate the renaming of a great number of common well-known species is a most lamentable affair. To do it without most essential taxonomic needs is indefensible. To do it because some other group has a greater ratio of genera to species, as recently advocated by a well-known authority in a certain group, seems to imply a total disregard of the real needs and purposes of a nomenclatorial system.

ZOOLOGICAL PHILOSOPHY

The great problems of human society, racial, sexual, industrial, commercial, have their basic foundations in conditions that are fundamentally zoological—that is, dependent upon the animal nature of man and having their roots far back in the soil of animal life of which man is a part, even if he is the most recent and dominant of the process of evolution.

Whether we will or not, we must recognize these inherited conditions and capacities of our species and may well consider in what regard the fundamental laws of evolution apply to present-day problems of human development. Shall we still adhere to the idea of brute force as the determining factor in the survival of the fittest or shall we adjust our vision to the conception of ideas of justice, morality, love for the beautiful and of ethical standards as the highest and most advanced product of that great force of evolution which we, as zoologists, most confidently accept as the method of the universe? Shall we do our utmost to preserve and develop these latest, finest, most attractive products of evolution or permit them to degenerate like vestiges of unused organs?

Possibly I may have been alone, but I suspect that many of my zoological friends have found the past few months a time of soul-

searching questioning and review of our accepted beliefs in organic evolution, to discover if possible whether there is any warrant for the claim that they can be made to support and justify, even in distorted form, such unspeakably inhuman activities as have followed in the wake of the attempt to establish domination for a self-styled superior race. Of course we may now interpret the result if we choose as establishing the place of the triumphant side in the contest, but I do not think we need stop to argue concerning the "fittest" in this "struggle for existence." There is too much to be done, too many vital issues at stake for human progress in the immediate future and all our resources in thought and action will be demanded in their solution. But, granting all this, must we not face the cold fact that our basic principle in organic evolution is capable of misinterpretation or misapplication when it is in any way possible for it to be invoked as the justification for starting such a train of misery and death to the nations of the whole world? It takes remarkable optimism concerning the betterment of mankind as the results of this war (and unquestionably betterment may come in many regards) in order to feel that the evolution of our human family to higher conceptions of order and cooperation in national affairs could not have been achieved without the tremendous, monstrous cost of such a war.

Ought we not in all fairness to a biological principle which we believe to have been the basis of all our achievements in morality, altruism and ethical standards of human society to see if possible that its basic principles, its proper interpretations and its proper results are so impressed upon our biological thought and policies of education that zoology as a science can never again be charged with such infamous doctrine as a support for the divine right of kings or the origin of a world war such as has agonized the nations of the present day.

The growth and progress of science itself has so much at stake that, even with a narrow selfish interest in the advancement of our special branch of study, we can not be in-

different, but as part of a greater educational world and a still greater world of human activity we owe it to ourselves and our science that our principles be not only well established, but that they are correctly interpreted to the world at large. We have here not only a great aim but a great and most significant opportunity. If our statesmen can be brought to think and act on the basis of a most enlightened biological interpretation of the world and human society, I believe we need have little fear for the safety of future generations.

AGENCIES FOR RESEARCH

In organized agencies or zoological research we certainly have reason to be proud and to feel that we have the basis for extensive enterprises and rapid development. The governmental bureaus of Biological Survey, Fisheries, Animal Industry and Entomology, which have been contributing very largely to the growth of zoological science in recent years, are facing new opportunities and will have had their activities stimulated by recent events. While they have no doubt been handicapped by the temporary or permanent loss of many of their workers it is certainly to be expected that they will resume their work with renewed zeal and efficiency.

In the universities, colleges and experiment stations where there has been perhaps the heaviest drain on the younger workers, who naturally form a very large per cent. of the active force, there should be prompt resumption of activity and researches along many lines that have been suggested by problems faced during the war, which will offer unlimited opportunity for ingenuity and original investigation. So to the museums, state academies, surveys and all the institutions interested in exploration or research will spring to renewed activity.

In view of the many agencies of this kind and the large support given to zoological research it is fair to ask whether we are getting the utmost in return and whether there are any tendencies in these organizations inimical to the most effective results? It is perhaps hardly to be expected that we have an ideal

condition of ample support for research with untrammelled freedom both in subject and method of work. It does seem fair to expect and demand that the necessary administrative restrictions, committee approvals, financial safeguards, and all the other factors of delay and annoyance to the investigator should be reduced to the lowest possible minimum.

EDUCATIONAL ASPECTS

To the thoughtful student of zoology and especially, I think, to the teacher who reflects upon the relation of his subject to the development of scholarship and character, or its relationship to the general welfare and advancement of human society, a question that now looms large on his horizon is whether we are using this material and effort in the way to secure the greatest benefit.

Our systems of instruction have been developed largely with the traditional methods for other subjects in mind, or often with the necessity of adapting work to schedules or methods in vogue in other quite different fields of knowledge. Even didactic methods have been more or less forced by influences quite out of harmony with biological spirit and needs.

That these have been unsatisfactory in many ways has been attested by many efforts to break away from the conventional plans, but possibly most conspicuously by the establishment of the many summer schools, field stations, or laboratories where biologists may handle instruction on plans adapted to the material and to the conditions under which life exists and under which it should be studied.

Unfortunately, this method has been developed mainly with reference to mature individuals and, while the service rendered through teachers with such experience and training may be of great value, it would seem entirely unnecessary to argue for such a plan to be applied to beginners as well. Indeed, many of the summer camps for boys and girls, the activities of the boy scouts movement and courses now offered in some schools give evidence of attempting such methods, but if of

advantage for the few why not for the many and why should not the essentials of such method be utilized to the greatest possible extent for all pupils who enter on the study of living things, and which as living things, should be studied under the conditions which recognize the life factor!

Perhaps, to state my view in brief, I would say that the first instruction in zoology should be training in observation. The natural curiosity of the pupil concerning the living things about him should be stimulated and gratified, not smothered by the cold reception of unsympathetic teachers. If connected with the practical biological problems of his daily life I believe it will be all the more effective.

If the subject is taken in the high school it may advance to some of the most obvious facts and principles of biology, but it seems to me this period should be concerned much more with recognition of facts and giving acquaintance with living things, than with attempts at the more profound generalizations. If the student has his interest stimulated and carries his study further, this foundation will be far more valuable than a drill upon speculations the nature of which is beyond the comprehension of the immature mind. If he never gets beyond this stage it will serve him far better for the problems of life than hazy notions of zoological theory.

A somewhat similar view applies to the general or introductory course in zoology for the college, which should be planned for the great body of students who take the subject as a part (and, I believe, a most essential part) of their general education, not for the very small percentage who may later become professional zoologists. That is, the first demarkation should come after the more fundamental basis has been laid for the good of the specialist as well as for the sake of the majority whose school work in the subject stops with the one course.

Obviously the content of the course and the method of treatment should be adapted to the maturer minds and may deal with significances and interpretations as well as facts, but in a broad way should follow the same

principle of personal contact with the material on which the instruction is based.

Just now the content of the first college course and the time allotted to it seems to me to be of very grave concern, as many influences are operating to change its status.

To ignore or minimize these is to endanger the position already secured after many years of effort and to me this is to endanger the whole fabric of our educational system, as I deem the biological point of view and mode of attack of the greatest concern to a properly balanced and rounded education.

The great increase of subjects offered in our elective systems of education; the constant effort of the devotees of each branch to secure more and more time with minuter subdivisions of subjects or greater numbers of students, results in the practical elimination of certain subjects from the curriculum for many individual students. The demand of special, technical or professional schools for certain phases of the subject, or its limitation to very meager time, threatens to reduce the time and scope of work with serious disadvantage to both teacher and student. The call for special courses is highly encouraging as an evidence of the place zoology has come to occupy in these fields, still the supposed wants of medical, dental, sociological and agricultural students puts a serious strain upon the teacher who feels that there are certain fundamental things that are essential to proper handling of any subject resting upon biological foundations.

Moreover, under the stress of national emergency, we have been straining to give intensive or specialized courses containing the greatest amount of essential matter, especially economic, in the shortest possible time. Whether we will or no, there is likely to come the view either to the student or the administrator of student curricula, that if such intensive courses are effective in an emergency they might well be useful at other times. In any case we may be obliged to face the alternative of giving what seems zoologically most necessary in briefer courses, or seeing many of the students who ought normally to

get the training it affords disappear from our laboratories.²

I feel very certain, however, that whatever may be necessary in the way of concentration or reduction of time, we must insist on a proper balance of the various fundamentals in our subject, a proper combination of morphology, physiology, ontogeny, ecology, genetics, distribution, evolution, taxonomy and the basic principles of economic practice, as essential to a proper perspective and to any recognition of the proportion and values, the omission of any one of which will result in imperfect views.

To borrow a simile from the field of animal nutrition we must have a balanced ration to ensure symmetry of growth and completeness of development and I can not approve efforts to give introductory courses based on any one of these elements to the exclusion of others no matter how fundamental and necessary they may be to the structure as a whole.

In the same way I can not endorse selection on the base of any one group of animals. While it is true that practically all biological principles may be illustrated within the confines of a single class of animals such limitation must necessarily result in a narrower conception of the animal kingdom as a whole.

I confidently believe that almost every phase of life can be found among the insects and, as a specialist in Hemiptera, I have often had occasion to remark that this one group of insects can easily be made to exhibit the greatest variety of biological principles. The same no doubt can be claimed by the specialist in almost any general group. But to make such a selection in our elementary training courses

² I note in a recent number of SCIENCE (November 22, 1918) in an article by Professor Bradley M. Davis on "Botany after the War" that the same questions concerning instruction in botany are confronting our brothers in biology and it is very evident that much may be said in one branch which will apply with equal force in the other. The important point for us is to decide whether we shall rise to meet the new vision and either justify and defend our present standards or adapt them to coming needs that may require new alignments.

would, it seems to me, defeat many of the most important objects of our college work.

There may well be differences of opinion as to the sequence and proportion of the different phases of zoology to be contained in the introductory course. I grant too that some latitude may be allowed for the preferences and training of the individual instructor but, conceding this, it seems to me that there are certain fundamentals that should be provided for at some period or in some form in any course that claims to give the student the basis either for further work in zoology or for the general problems of life or their applications in agriculture, medicine or commerce.

Morphology must certainly stand as one, if not the first, of these fundamental points, not only because it forms the essential basis for all taxonomic, biologic, faunistic or other work but because it is *par excellence* the part of zoology which once learned is a permanent foundation for the shifting structures of biologic interpretation. Whatever speculations may follow as to significance, function, origin, etc., the organs and their parts remain a basic fact practically unchanged from generation to generation and the final resort in all controversy in biological interpretation.

Just how much laboratory dissection or anatomic demonstration is absolutely necessary may be open to debate but as to its essential character I think we must all agree. Next and closely associated with morphology I place physiology, because the activities of animals are certainly of vital consequence in all developments of biological knowledge. Moreover, it is only on the basis of their functions that animal structures can be properly understood. I sometimes feel that it is regrettable that physiology and anatomy should have been so widely separated in more advanced courses, although this is in some degree an inevitable result of specialization. But certainly for elementary courses such separation is indefensible.

The extent and character of the physiological element, however, is subject to wide variation with different instructors and a proper balance may be hard to determine. From the

nature of the case it is impossible to carry this phase into the many debatable fields of physiologic interpretation and I believe the best results will be secured by centering attention on those functions most easily associated with the structures studied. The well-established facts of digestion, circulation, respiration, excretion, nervous activities and reproduction can best be presented in connection with the study of the organs involved and if these are taken up in a comparative series of the major groups of animals, the nature of these fundamental activities should be firmly fixed in the mind of the student. Reproduction especially, with the associated phenomena of growth, metamorphosis, inheritance, etc., can most profitably come in as parts of a progressive system leading from lower to higher forms not only to show the gradual evolution of the system but as a most natural and desirable introduction for the presentation of sexual hygiene so vitally important for the happiness of the individual and to the perpetuity and progress of the race.

Ecology for the introductory course should be given large attention, but rather as a means of fixing the significance of structure and activity than as a separate field of study. So too the economic relationships may be profitably treated as associated with function and ecology.

The main facts of geographical distribution may have been suggested in the discussion of various animals, but discussion of migration and adaptation can hardly be omitted in a summary of biologic factors and with the foundation of a comparative study of the great groups of animals with indication of their historical development, the basic principles of the evolution of animals may be undertaken.

The amount of time accorded to classification is again a matter of great difference of opinion and practise. With the more special problems of taxonomy it is certainly unwise to deal in a class of general students. Puzzling and intricate problems of taxonomy should be presented to technical students in later courses and in much greater detail than would be

possible to a general class. But to omit the broad foundations of classification or to neglect its connection with its morphological basis is to lose one of the best mental disciplines and also to leave the student without that systematized grouping of facts with which he is dealing, that is so fundamentally essential to any clear grasp of correlations, or the orderly handling of facts that present themselves in the course of his life. I know of no discipline better, to give training in the systematic arrangement of matter than through the basic principles involved in the orderly arrangement of the myriad forms of animal life.

Above all of course we should have freedom of action for the individual teacher. The best in any teacher may be expected only when he can give his whole heart and enthusiasm to his work. I believe that it is possible with intelligent and sympathetic co-operation to secure both this freedom of action and a well-balanced and correlated agreement on the main content and aim of instruction and with this goes opportunity and responsibility which we need not attempt to measure.

I make no apology for introducing what may seem at first sight a rather primary and academic discussion in this line. We must all recognize that the ranks of our future zoological workers must be recruited in large part if not entirely from among the students of our high schools and colleges. It is certainly most vital to the progress of our science that we secure our share of the best talent represented among such students. It is of even greater consequence that the coming generation should have such fundamental training in the activities of life that they may be best qualified for citizenship.

I have purposely omitted any detailed discussion of the more advanced courses of zoological study offered in our college or university curricula, partly because I feel that there is the greater need of careful, constructive attention to our introductory courses, which should by all means have the advantage of the most able and experienced teachers, and

partly because the drift and detail of the more specialized courses will be in considerable part a response to the changing demands of passing years. Our product of the advanced training should, certainly provide us with qualified investigators and teachers in the many phases of zoological work. There is, however, I fear, a tendency to meet so many of these purposes that we are in danger of offering entirely too many special subjects as courses for undergraduate students. Zoology has perhaps not gone to the extreme of certain other departments of education, some of which appear to me entirely out of reason, but I find for instance in one of our well known schools no less than 57 different subjects offered as regular lecture or laboratory courses. Could not many of these more profitably stand as subjects for the individual student in seminary or graduate work or ought not the student with proper biological foundation to be able to follow them up independently after cutting loose from the leading strings of his academic instructors. Some of his time as an undergraduate ought certainly to be allotted to work that will give him the spirit and method of research, so that with separation from direct supervision he may meet the responsibilities and opportunities of adding to science with whatever talent and resource he may possess for original work.

EXTENSION ACTIVITIES

Within the last few years we have witnessed the organization of a plan of extension activities in education which is nation-wide in scope and the full significance of which, at least for zoology, I suspect we have failed to fully realize. The support available through the Smith-Lever act, while relating particularly to agriculture and home economics covers these in a broad way and, even in a rather close interpretation, must involve extension activities in biological lines, and zoologists will fail to meet their opportunities if they do not energetically occupy this field of endeavor.

That the field is pregnant with great possibilities may be surmised if we but review the

host of connections existing between zoological knowledge and agricultural practise. Not a single farm product but is affected directly or indirectly by some animal activity and the extent of unutilized zoology available is perhaps equalled only by the ignorance and indifference of a large part of the population most in need of accurate and intelligible information.

Some twenty years ago I took occasion to say in an address before the Association of Economic Entomologists that

The problem or how to reach with the facts we have gathered the people for whom we work is one of the most difficult to solve. . . . No matter how carefully we experiment, how accurate and useful our results, we must place these results before a public uneducated in the details of our science.

The situation there referred to, though no doubt improved, is in some degree true to-day, but for a large part of the gain I believe we must credit the various extension agencies which have been developing in recent years.

Possibly some measure of this gain may be found in the enormous growth of the use of insecticides for the control of certain farm and orchard pests.

CONCLUSION

Finally then, in sum, I think we may say in confidence that zoology with its centuries of development stands as a great achievement of human thought and study; that it offers unlimited opportunity for further research and growth and that its aims and opportunities deserve the most ardent effort of its devotees.

Here at the most conspicuous milestone perhaps ever erected in the progress of the human race the passing generation of zoologists may hand on to the coming workers not only the product of generations of effort but the priceless opportunity of unsolved problems, the gift of possible achievements for many generations to come.

I appreciate that this is not a valedictory or an address to a graduating class and I beg pardon if I overstep the proprieties of the

occasion, but the conditions of the day have impelled such appraisal of the situation and the occasional taking account of stock is perhaps at times a most necessary and profitable step in our undertakings.

I realize that there are many here present whose range of study and point of view must enable them to see with wider horizon and clearer vision the great domain, small tracts of which it is our individual function to cultivate, but I trust I may have your unanimous agreement to the sentiment that these various activities, so hurriedly sketched, so inadequately presented, are worthy of our most enthusiastic endeavor, our most loyal devotion and cooperation.

HERBERT OSBORN

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND SCIENTIFIC ORGANIZATION

THE revised constitution of the American Association, presented at the Baltimore Meeting for adoption at the St. Louis Meeting, contains the following articles:

ARTICLE 6. DIVISIONS AND BRANCHES

Regional Divisions and Local Branches of the association may be formed by vote of the council. Such divisions and branches may elect officers, hold meetings, appoint committees, enter into relations with other societies, and promote within their fields the objects of the association.

ARTICLE 7. ASSOCIATED AND AFFILIATED SOCIETIES

National and local scientific societies may, by vote of the council, become associated with the association. Those associated societies which the council shall designate as affiliated societies are represented on the council and on the sectional committees as provided in articles 4 and 5.

These articles state the policy of the association as framed by the council in recent years. All the national scientific societies, including the great engineering societies and the American Medical Association, are now affiliated with the association and represented on its council. A Pacific Division has been formed which serves as a center for the scien-